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Integrating Robotic Applications into Blended Learning to Decrease Mathematics Anxiety in Primary Education

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Abstract: Mathematics anxiety is a pervasive global barrier to student achievement and engagement, particularly in primary education. This study describe the potential of robotic applications, implemented within blended learning environments, to mitigate mathematics anxiety and improve learning outcomes. A sequential mixed-methods design was employed, comprising a quantitative survey (N=150) and semi-structured interviews (N=25) with pre-service teachers, in-service teachers, and faculty members in te partner countries (Bulgaria Latvia Lithuania, Poland and Türkiye). Survey results demonstrated strong positive perceptions: 88.4% agreed that robotics enhances mathematical success, and over 90% believed it makes mathematics more enjoyable and motivating for anxious students. However, a significant confidence gap was identified; while 80% expressed a desire to use robotics, only 38.4% felt confident in their ability to program robots. Interview findings corroborated these results, emphasizing the limitations of traditional abstract teaching and the potential of robotics to provide tangible, engaging experiences in teaching counting, measurement, and data processing. In response, the project team developed ten modular curriculum units designed to integrate robotics into primary mathematics education within a blended learning framework. The findings indicate that robotics can significantly reduce mathematics anxiety, provided educators receive adequate training, resources, and institutional support to bridge the efficacy gap.

Keywords: Mathematics Anxiety, Modular Curriculum, Robotic Application, Primary School Education.

I. INTRODUCTION

With an emphasis on integrating robotics and blended learning to alleviate mathematical fear and improve student engagement, the literature review offers a thorough cross-country investigation of mathematics education in primary schools throughout Bulgaria, Latvia, Lithuania, Poland, and Turkey. The evaluation is a component of a larger international initiative that aims to create a digital teaching guide, a smart video platform, and a modular curriculum based on robotics to assist pre-service and in-service instructors.

Mathematics anxiety, characterized by feelings of tension and fear that interfere with manipulating numbers and solving mathematical problems, is a well-documented global issue (Ramirez,2021). It often originates in primary school and can lead to long-term avoidance of mathematics, limiting future academic and career choices ‘Sung, 2022). Traditional pedagogical methods, which can be abstract and heavily reliant on rote memorization, frequently contribute to this anxiety (Olson, 2023). The evolution of educational technology offers novel avenues to address this challenge. Blended learning, which combines traditional face-to-face instruction with online digital media, provides a flexible environment for integrating innovative tools (Kim, 2020). Among these tools, robotics has emerged as a powerful engaging platform. Robots can provide tangible, interactive, and immediate feedback, making abstract mathematical concepts more concrete and accessible (Bers, 2021).

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This paper presents a national study that explores the perceptions of educators regarding the use of robotics in mathematics teaching. The study had two primary objectives: 1) to assess the perceived benefits and challenges of using robotic applications to reduce mathematics anxiety and improve learning, and 2) to develop and propose educational modules based on these findings. The research questions guiding this study were:

RQ1: What are the perceptions of pre-service and in-service teachers regarding the impact of robotic applications on student success, engagement, and anxiety in mathematics?
RQ2: What are the perceived challenges and support needs for implementing robotics in mathematics education?
RQ3: How can robotic applications be effectively designed to teach specific mathematical concepts like numbers, measurement, and data processing?

II. LITERTURE REVIEW

Mathematics anxiety (MA) is widely recognized as a major obstacle to effective learning, impacting nearly one in five learners across different educational levels. It often emerges through feelings of apprehension, tension, or even physical discomfort when students are confronted with mathematical tasks. Such experiences can erode self-confidence, lower academic achievement, and restrict future educational and professional opportunities. To address this challenge, the project positions robotic technologies as powerful “cognitive tools” that transform the learning process. By enabling interactive, collaborative, and engaging activities, these technologies aim to reduce anxiety, enhance motivation, and promote the development of strong mathematical literacy.

Mathematics anxiety is more than a simple dislike of the subject; it is a complex, affective barrier that manifests cognitively, physiologically, and behaviorally. Cognitively, it consumes working memory resources, leading to decreased performance on mathematical tasks (Ramirez, 2021). Physiologically, it can trigger stress responses. Behaviorally, it leads to avoidance, creating a vicious cycle where lack of practice further increases anxiety and decreases competency. Its origins are often traced to primary school, where negative early experiences with mathematics—such as timed tests, public correction, or instruction that prioritizes speed over understanding—can cement a lifelong belief that one is "not a math person".

Effective interventions for MA are often grounded in constructivist and social-constructivist theories, which posit that knowledge is built through active, social, and experiential learning. Robotics aligns perfectly with this paradigm, offering a platform for collaborative problem-solving and discovery. Furthermore, the theory of ‘embodied cognition’ provides a strong foundation for using robotics. This theory suggests that cognitive processes are deeply rooted in the body's interactions with the world (Mishra and Koehler, 2006). By allowing students to physically manipulate robots to understand abstract concepts like distance (measurement) or sequence (algebraic thinking), robotics grounds mathematical reasoning in sensory and motor experiences, making it more intuitive and less anxiety-provoking.

A. Mathematics Education and Anxiety Across Countries

Latvia

Latvia has undergone significant curriculum reforms since 1998, shifting from reproductive learning to a competence-based approach emphasizing problem-solving, critical thinking, and real-world application. The *Skola2030* initiative promotes transversal skills such as digital literacy and collaboration. Despite above-average TIMSS scores, math anxiety remains under-researched. Social-emotional learning (SEL) and positive school climates are encouraged to support student well-being.

Latvia's significant curriculum reforms since 1998 have shifted focus from reproductive learning to a competence-based approach emphasizing problem-solving, critical thinking, and real-world application. The initiative promotes transversal skills such as digital literacy and collaboration. Despite above-average TIMSS scores, math anxiety remains an under-researched area. Current strategies encourage social-emotional learning (SEL) and positive school climates to support student well-being, providing a fertile ground for integrating anxiety-reducing technologies like robotics.

Lithuania

Lithuania’s mathematics education focuses on holistic, child-centered learning. Recent declines in national math scores have prompted initiatives to integrate innovative teaching methods. Math anxiety is recognized as a transgenerational

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issue, influenced by teacher and parental attitudes. Recommendations include game-based learning and real-life applications to reduce anxiety.

Lithuania's child-centered approach to mathematics education faces challenges from recent declines in national math scores. Math anxiety is recognized as a transgenerational issue, often perpetuated by teacher and parental attitudes. National initiatives now promote the integration of innovative teaching methods, with specific recommendations for game-based learning and real-life applications to reduce anxiety and make learning more engaging.

Bulgaria

Bulgarian math education aims to develop foundational arithmetic and geometric skills, with an emphasis on interdisciplinary connections and practical problem-solving. TIMSS results indicate stable but polarized achievement levels. Math anxiety is linked to low motivation and negative perceptions of math's usefulness. Interventions include gamification, technology integration, and parental involvement.

Bulgarian mathematics education focuses on developing strong foundational arithmetic and geometric skills, with an emphasis on interdisciplinary connections and practical problem-solving. TIMSS results indicate stable but polarized achievement levels. Math anxiety is strongly linked to low student motivation and negative perceptions of math's usefulness. Interventions are increasingly focusing on gamification, technology integration, and strategies to involve parents in creating a positive math environment at home.

Poland

Poland's education system has undergone significant reforms, leading to notable improvements in PISA rankings. The curriculum emphasizes critical thinking and problem-solving. While not as extensively documented as other regions, math anxiety is recognized, and there is a growing interest in integrating technology and STEM methodologies, including robotics, to create more engaging and effective learning environments. Initiatives often stem from local schools and NGOs, indicating a bottom-up approach to innovation.

Turkey

Turkey's 12-year compulsory education system includes a mathematics curriculum aligned with the Turkish Qualifications Framework. The curriculum aims to develop analytical, creative, and critical thinking skills. Math anxiety is addressed through positive learning environments and innovative pedagogical approaches.

Turkey's 12-year compulsory education system includes a mathematics curriculum aligned with the Turkish Qualifications Framework (TQF), aiming to develop analytical, creative, and critical thinking skills. While the curriculum modernizes content, pedagogical practices can sometimes lag behind. Math anxiety is acknowledged as a significant issue, and the national strategy encourages the creation of positive learning environments and the adoption of innovative pedagogical approaches, including technology integration, to address it.

B. Robotics in Mathematics Education

Theoretical Foundations

Robotics is conceptualized as an intellectual tool that supports collaborative problem-solving and computational thinking. It offers tangible, interactive experiences that make abstract mathematical concepts (e.g., geometry, algorithms, measurement) accessible and engaging. Key benefits include:

- **Enhanced Engagement**: Robots capture attention and encourage active participation.
- **Personalized Learning**: Adaptable to individual learning paces and styles.
- **Real-World Application**: Bridges theory and practice through hands-on activities.
- **Development of 21st-Century Skills**: Fosters creativity, critical thinking, and collaboration.

Computational Thinking

Robotics introduces computational thinking components such as abstraction, algorithmic thinking, decomposition, debugging, and generalization. These skills align closely with mathematical reasoning and support the development of logical and structured problem-solving abilities. A critical component of robotics integration is the development of

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computational thinking (CT). CT involves skills such as abstraction, algorithmic thinking, decomposition, debugging, and generalization [11]. These processes are not separate from mathematical thinking; they are its parallel. Designing a path for a robot (algorithmic thinking) is akin to designing a solution to a word problem. Debugging a faulty code is a process of error analysis and perseverance. Thus, robotics serves as a dual-purpose tool, simultaneously teaching mathematical content and strengthening the cognitive processes that underlie it.

National Initiatives

- **Latvia**: Projects like *STEAM Masterminds* and private initiatives (e.g., AlfaRobot, RoboHUB) promote robotics in schools.
- **Lithuania**: Schools like Kaunas Varpelis and programs like *Robotika Academy* integrate LEGO robotics into math lessons.
- **Bulgaria**: The *Skills for Innovation* program and National STEM Center support teacher training and resource development.
- **Poland**:
- **Turkey**: Robotics is increasingly incorporated into STEM education, though specific national initiatives are less documented.

C. Blended and Flipped Learning Approaches

1) Blended Learning: A Seamless Integration of Traditional and Digital Education Models

Blended learning represents a dynamic educational approach that merges the best of both worlds: traditional face-to-face instruction and the flexibility of online digital tools. This combination allows students to enjoy the benefits of in-person interaction while also leveraging the personalization and convenience of digital learning resources. By integrating technology into the classroom, blended learning offers a diverse range of benefits, including:

- **Diverse Learning Styles**: By offering a blend of face-to-face and digital content, blended learning caters to various learning preferences—whether visual, auditory, or kinesthetic—ensuring that all students have the opportunity to thrive in an environment that suits their needs.
- **Digital Literacy**: As technology becomes an integral part of education and the workplace, blended learning helps both students and educators develop crucial technological competencies. This prepares learners for the demands of an increasingly digital world, fostering critical skills such as navigating online platforms, utilizing educational tools, and engaging in virtual collaboration.
- **Resource Accessibility**: Online learning platforms such as Moodle and EDUKA have become essential tools for facilitating access to educational resources. These platforms offer seamless communication between students and teachers, content sharing, assessment tools, and collaborative spaces. Whether in rural, urban, or international contexts, blended learning ensures educational resources are accessible to diverse populations, transcending geographical and economic barriers.

2) Flipped Learning: Empowering Students through Independent Learning and Interactive Engagement

Flipped learning is an innovative pedagogical model that shifts the traditional classroom dynamic. In this model, students are assigned instructional content (such as videos, articles, or interactive modules) to engage with outside of class. Classroom time is then repurposed for collaborative, high-level activities, such as discussions, debates, problem-solving exercises, and projects. The flipped classroom transforms the role of the teacher, from the primary source of information to a guide and facilitator, allowing for deeper learning experiences. Key benefits of flipped learning include:

- **Promotes Self-Regulation**: Flipped learning empowers students to take charge of their own learning process. By engaging with content outside of class, students develop time-management and self-regulation skills. This approach encourages personal responsibility, fostering lifelong learners who are better equipped to work independently.
- **Enhances Interaction**: By using class time for active engagement rather than passive listening, flipped learning promotes interaction between students and instructors. Teachers can offer more personalized guidance, and students have the opportunity to collaborate with their peers, asking questions and clarifying concepts in real-time.
- **Supports Deep Learning**: The flipped classroom model creates opportunities for higher-order thinking. Students can focus on applying, analyzing, and synthesizing knowledge during class activities, rather than just memorizing content. This approach fosters critical thinking, problem-solving skills, and the ability to transfer knowledge to real-world scenarios, which are essential for deeper and more meaningful learning.

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III. METHODOLOGY

A. Participants

The study was conducted in the partner countries. The **survey** involved 150 participants (81.7% female; 18.3% male), evenly split between pre-service and in-service teachers. The **interviews** included 25 participants (20 female; 5 male): 11 pre-service teachers, 10 in-service teachers, and 4 faculty members.

IV. DATA COLLECTION

- **Survey:** The quantitative survey involved 150 participants. The demographic breakdown showed a predominance of female participants (81.7%), reflecting the gender distribution common in teacher education programs and primary teaching in Türkiye. The sample was evenly split between pre-service teachers (50%) and in-service teachers (50%), ensuring perspectives from both those preparing for the profession and those currently within it. Seventeen Likert-scale items (1=Strongly Disagree; 5=Totally Agree) measured perceptions of robotics in mathematics teaching.
- **Interviews:** From the larger survey pool, 25 participants were selected for in-depth semi-structured interviews. This subgroup consisted of 20 females and 5 males, comprising 11 pre-service teachers, 10 in-service teachers, and 4 faculty members with expertise in mathematics education. This selection ensured a triangulation of perspectives from novice teachers, experienced practitioners, and academic experts..Four open-ended questions explored experiences with mathematics anxiety, perceived benefits of technology, and specific uses of robotics.

V. DATA ANALYSIS

Descriptive statistics were applied to survey data. Interview transcripts were analyzed using thematic coding to extract recurring patterns.

Quantitative Data: Survey data were analyzed using descriptive statistics (means, standard deviations, frequencies, and percentages) with IBM SPSS Statistics (Version 28). This analysis provided a clear picture of the general trends and attitudes within the sample.

Qualitative Data: Interview recordings were transcribed verbatim. The transcripts were then analyzed using thematic analysis following the steps outlined by Braun and Clarke. This involved familiarization with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the report. The qualitative analysis software NVivo was used to assist in organizing and coding the data, ensuring a systematic and rigorous process.

Ethical Considerations
Informed consent was obtained from all participants. They were assured of confidentiality and anonymity, with all identifying information removed from the reported data. Participants were informed that their involvement was voluntary and that they could withdraw from the study at any time without penalty.

VI. SURVEY AND INTERVIEW RESULTS

Survey results revealed overwhelmingly positive attitudes towards robotics in mathematics education.

- **Achievement & Engagement:** 88.4% agreed robotics improves mathematical success; 91.7% agreed it makes lessons enjoyable; 90% said it motivates anxious students.
- **Conceptual Clarity:** 86.6% agreed robotics makes math problems more understandable; 88.4% agreed it develops thinking skills.
- **Teacher Willingness vs. Confidence:** While 80% wished to use robotics in class, only 60% felt capable of doing so effectively. Confidence in programming robots was notably low (38.4%).

This divergence highlights enthusiasm tempered by self-efficacy concerns. Cost was a moderate concern (25%), but 91.7% dismissed claims that robotics is overemphasized.

Despite this optimism, the data revealed a significant confidence gap. While 80% expressed a desire to use robotics, a lower percentage felt they could use them effectively (60%) or found them easy to learn (55%). Notably, only 38.4% felt confident in their ability to program a robot for educational purposes. This underscores a critical need for

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professional development. A minority (25%) viewed robotics as costly, but an overwhelming 91.7% rejected the notion that such methods are overemphasized or not useful.

Thematic analysis of the interviews provided deeper insights into the quantitative findings.

1. **Sources of Math Anxiety:** Participants identified early negative experiences, pressure from traditional teaching methods, and students' preconceived notions of difficulty as key contributors.
2. **Technology as a Remedy:** Technology was seen as an effective means to increase participation, align with students' digital preferences, and make mathematics enjoyable.
3. **Robotics in Practice:**
    - *Counting & Numbers:* Using robots for interactive games, songs, and coding to reinforce number sense.
    - *Measurement & Data Processing:* Employing robots with distance and light sensors to collect and analyze data, thereby connecting mathematics with real-world applications.

A. Mathematics Anxiety and Traditional Teaching

Participants universally recognized mathematics anxiety in primary schools, attributing it to students' preconceived notions of difficulty and traditional, abstract teaching methods focused on board work. One faculty member noted, *"Students often enter school with a preconceived notion that mathematics is difficult... exacerbated by traditional teaching methods."*

B. Technology as a Tool for Engagement

There was a strong consensus that technology is a powerful tool for alleviating anxiety. Participants highlighted its role in increasing participation and attention, leveraging students' familiarity with digital devices, and making learning enjoyable. A teacher stated, *"The key to eliminating math anxiety is making students love mathematics through games and new technological applications."

C. Specific Applications for Robotics

Participants proposed creative methods for using robots:

- Numbers & Counting: Interactive games, songs, coding activities, and visual-auditory supports to make learning engaging and permanent.
- Measurement & Data Processing: Using robots with integrated sensors (e.g., distance, light) for hands-on measurement activities. Robotic coding was emphasized for teaching data collection, processing, and analysis through project-based learning. Participants suggested that *"robots can process collected data, such as temperature... providing a concrete understanding of mathematical and scientific concepts."*

D. Quantitative Survey Findings

Survey results revealed overwhelmingly positive attitudes towards the potential of robotics in mathematics education, but also highlighted a significant preparedness gap.

Perceived Impact on Achievement & Engagement:

- 88.4% of participants (Agree + Strongly Agree) believed that robotics applications increase success in mathematics.
- 91.7% agreed that these applications make mathematics lessons more enjoyable.
- 90.0% agreed that robotics can motivate students who experience mathematics anxiety.

Perceived Impact on Conceptual Clarity:

- 86.6% agreed that robotics makes abstract math problems more concrete and understandable.
- 88.4% agreed that it helps develop mathematical thinking and problem-solving skills.

Teacher Willingness vs. Confidence (The Efficacy Gap):

- While 80% of respondents expressed a desire to use robotics in their classrooms, a significantly lower percentage felt capable of doing so effectively (60%).
- Only 55% found robotics applications easy to learn.

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- Most strikingly, confidence in the specific skill of programming was notably low, with only 38.4% feeling confident in their ability to program a robot for educational purposes. This divergence highlights a critical enthusiasm-efficacy gap.

Perceived Barriers:
- Cost was a moderate concern, with 25% viewing robotics as a costly intervention.
- However, an overwhelming 91.7% rejected the notion that such technological methods are overemphasized or not useful, indicating strong belief in their value despite the barriers.

E. Qualitative Interview Findings

Thematic analysis of the interviews provided deeper insights and context for the quantitative findings, yielding three major themes.

Theme 1: Sources and Nature of Mathematics Anxiety
Participants universally recognized mathematics anxiety as a prevalent issue in primary schools. They attributed its origins to several key factors:
- Early Negative Experiences: Many interviewees described how early struggles with basic concepts, if not addressed with support, can snowball into a generalized fear of math.
- Traditional Pedagogical Methods: The most frequently cited cause was traditional instruction. Participants criticized methods focused on "board work," rote memorization of procedures, speed-based drills, and a lack of real-world connection. One faculty member noted, *"Students often enter school with a preconceived notion that mathematics is difficult… and this is exacerbated by traditional teaching methods that are abstract and fail to connect to their lives."*
- Societal and Parental Attitudes: Several teachers mentioned that anxiety is often reinforced at home by parents who themselves express negative attitudes about math, telling their children, "I was never good at math either."

Theme 2: Technology as a Catalytic Tool for Engagement
There was a strong, consensus-based belief that technology is a powerful tool for alleviating anxiety. Participants highlighted its role in:
- Increasing Participation and Attention: Digital tools were seen as a way to capture the attention of a generation of "digital natives."
- Leveraging Student Familiarity: Using devices and interfaces students are comfortable with helps lower the affective filter and reduces initial resistance.
- Making Learning Enjoyable: The core idea was that anxiety decreases as enjoyment increases. A teacher stated, "The key to eliminating math anxiety is making students love mathematics through games and new technological applications. Fear vanishes where there is fun."

Theme 3: Specific Applications and Practical Ideas for Robotics
Participants moved beyond abstract support and proposed concrete, creative methods for using robots to teach specific content areas:

Numbers & Counting:
- Using robots for interactive games (e.g., coding a robot to move to a specific number on a giant number line).
- Integrating songs and movements with robot actions to reinforce counting sequences.
- Using visual-auditory supports from coding software to make learning more multi-sensory and permanent.

Measurement & Data Processing:
- This was highlighted as the most promising application. Participants envisioned using robots equipped with sensors (e.g., ultrasonic distance sensors, light sensors) for hands-on measurement activities.
- Robotic coding was emphasized for teaching the entire data handling process: collection (e.g., programming the robot to measure the length of a corridor), processing (organizing the data in a table), analysis (finding the average distance), and representation (creating a graph). One participant suggested, *"Robots can process collected data and display it in a graph on a screen, allowing students to see the entire process from raw data to visual interpretation."*

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VII. PROPOSED EDUCATIONAL MODULES

Based on the identified needs and opportunities, we developed a series of modules for a blended learning environment. These modules are designed to be practical, addressing the confidence gap by providing structured lesson plans and activities.

1. Math Anxiety in Mathematics Education
   - Focuses on understanding, recognizing, and preventing math anxiety.
   - Includes breathing exercises, reflective activities, and collaborative tasks to build emotional resilience.

2. Mathematics Education in Primary Schools
   - Covers objectives, obstacles, affective aspects, and fun learning activities.
   - Emphasizes real-world connections and positive attitudes toward math.

3. Learning-Teaching Approaches
   - Compares traditional and modern teaching methods.
   - Highlights project-based and competency-based approaches.

4. Blended Learning Approach
   - Introduces blended learning models and their application in primary math education.
   - Discusses platforms like Google Classroom, Moodle, and interactive tools.

5. Flipped Learning Approach
   - Explores the flipped classroom model, its theoretical foundations, and practical implementation.
   - Focuses on student-centered learning and higher-order thinking skills.

6. Thinking Skills and Math
   - Develops critical and creative thinking through math.
   - Includes sample activities to foster problem-solving and logical reasoning.

7. Mathematics and Computational Thinking
   - Integrates computational and algorithmic thinking into math education.
   - Provides hands-on activities to build foundational tech skills.

8. Digital Supported Education
   - Highlights the role of digital tools in enhancing math learning.
   - Offers practical examples and platforms for digital integration.

9. STEM Approach
   - Introduces STEM education and its emotional and cognitive benefits.
   - Includes cross-disciplinary activities linking math with science and technology.

10. Use of Robotics in Education
   - Focuses on robotics as a tool for engaging math instruction.
   - Includes scenario-based learning and sample robotic activities.

VIII. DISCUSSION

The results strongly support the research questions that robotic applications are perceived as a highly effective tool for mitigating mathematics anxiety and improving engagement. The positive quantitative perceptions align with qualitative insights that robotics can transform abstract concepts into concrete, enjoyable experiences. This is consistent with existing literature on embodied cognition and hands-on learning (Bers,2021).

However, the identified confidence gap is a critical barrier to implementation. The success of any technological intervention is inherently linked to teacher readiness (Mishra and Koehler, 2006). The developed modules directly address this by providing a structured, low-entry-point framework that reduces the initial burden on teachers, allowing them to build confidence alongside their students.

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IX. CONCLUSION AND RECOMMENDATIONS

This study confirms the significant potential of robotic applications within a blended learning model to create a more engaging and less anxious mathematics learning environment. Educators recognize this potential but require support to realize it effectively.

The findings of this study strongly support the hypothesis that robotics, integrated within a blended learning framework, holds significant promise for reducing mathematics anxiety in primary education. The overwhelming positive perception from educators across experience levels underscores a readiness to embrace innovative pedagogies. However, the critical gap between enthusiasm and self-efficacy, particularly regarding programming skills, points to a clear and urgent need for targeted professional development.

The results align with and extend the existing literature. The emphasis on making abstract concepts concrete through tangible robotics supports the principles of embodied cognition (Mishra and Koehler, 2006). The identification of traditional methods as a primary source of anxiety corroborates findings by Olson (2023). The proposed applications for teaching measurement and data processing directly address the need for real-world, applied learning advocated by national curricula across the partner countries.

Based on our findings, we propose the following comprehensive recommendations:

1. Develop Modular, Curriculum-Aligned Robotics Units: Create a repository of open-access lesson plans and activities that directly link robotic tasks to specific national curriculum standards for mathematics. These modules should be designed for a blended learning environment, with pre-class digital content (videos, simulations) and in-class hands-on robot activities. Example modules include:
    - "Bee-Bot's Number Line Adventure" (Grades K-1, Numbers & Counting)
    - "Measuring the World with LEGO SPIKE" (Grades 3-4, Measurement & Data)
    - "Data Detectives: Collecting and Graphing with mBot" (Grades 4-5, Data Processing)

2. Implement Multi-Tiered Professional Development (PD): Teacher training cannot be a one-time workshop. A sustained PD model is required:
    - Tier 1 (Basic Proficiency):Hands-on workshops focused on building confidence in basic robot assembly and block-based programming (e.g., Scratch, mBlock).
    - Tier 2 (Pedagogical Integration):** Training on how to design lessons that effectively integrate the technology to achieve specific mathematical learning objectives, moving beyond the "wow factor."
    - Tier 3 (Community of Practice): Establish online and in-person communities where teachers can share successes, troubleshoot challenges, and co-develop new ideas.

3. Adopt a Phased, Sustainable Implementation Strategy: Schools should not attempt a full-scale rollout immediately. A pilot program is recommended:
    - Phase 1 (Pilot): Equip a single "champion" classroom or grade level with robotics kits and provide intensive PD to a small group of motivated teachers.
    - Phase 2 (Scale-Up): Use the pilot teachers as peer mentors to train and support additional teachers, gradually expanding the program.
    - Phase 3 (Institutionalization): Work towards securing a permanent budget line for technology maintenance and replacement, and formally integrate robotics into the school's curriculum maps and scope-and-sequence documents.

4. Promote Parental and Community Involvement: To combat negative societal attitudes, schools should host "Family Robotics Nights" or workshops where students can teach their parents how to program a robot to solve a math problem. This demystifies the technology and builds a more supportive home environment for innovative learning.

We recommend:
1. Prioritizing Teacher Training: Professional development programs must focus on both the technical skills of operating and programming educational robots and the pedagogical skills for integrating them into the curriculum.
2. Investing in Resources: Schools and policymakers should consider investing in accessible robotic kits and the technical infrastructure to support blended learning.
3. Further Research: Future studies should implement the proposed modules and empirically measure their impact on both student anxiety levels and mathematical achievement through experimental designs.

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By addressing the support needs of educators, we can harness the power of robotics to demystify mathematics and foster a generation of confident, capable learners.

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